GUIDELINE

Professional Engineers Providing Services With Respect to Roads, Bridges and Associated Facilities

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SCOPE

This guideline should be read in conjunction with the Foreword.

It is intended for use by professional engineers providing services related to planning, design, construction, rehabilitation, management and operation of roads, bridges and associated facilities. It does not replace existing standards, specifications, codes of practice, or engineering design requirements for such works and facilities.

1.1 Types Of Services

There are six major types of services required from professional engineers:

- project needs assessment;
- assessment of alternatives and impact analysis;
- preliminary design;
- detailed design, contract drawings and specifications;
- services during construction;
- related services.

The first three services are generally required as part of the environmental assessment process, leading to the submission and acceptance of an environmental study report on a project.

PROJECT NEEDS ASSESSMENT

Clients generally undertake projects in response to such identified problems or deficiencies as traffic congestion, traffic hazards, structural deterioration, high maintenance requirements, substandard geometrics, or inadequate service facilities. Although these problems may not be obvious to the public, it is necessary to document factors that lead to the conclusion that improvement is needed.

A *project needs assessment* should lead to development of a clear problem statement, identification of alternative solutions to problems or deficiencies, and confirmation of the process to be followed to meet the requirements of the Environmental Assessment Act.

In some cases, clients undertake a project needs assessment directly. Where clients require professional services, the following activities/ services are generally associated with this phase of a project.

2.1 Project Appraisal

A *project appraisal report* is prepared containing information on the project's:

- background and history;
- scope and complexity;
- study objectives;
- limits of study area;
- list of relevant factors to be considered;
- preliminary planning criteria, and
- recommended study method or approach.

2.2 Data Acquisition

During this phase of a project, engineers research relevant existing data and identify the need for additional information on such areas as transportation and the natural, social and economic environment. Additional data acquisition may be required to develop clear problem statements and/or to

identify /evaluate alternative solutions to problems.

The type of data required will depend on the type of problems/deficiencies. Data that could be required include:

- present and planned land use;
- present and projected traffic volumes and characteristics;
- service levels;
- condition surveys/reports;
- existing and future utilities;
- maintenance reports;
- accident reports;
- geotechnical and geoenvironmental;
- drainage and hydrology;
- topography;
- natural environment, for example fisheries and aquatic habitat, wildlife, vegetation, or wetlands;
- ambient noise levels;
- socioeconomic, for example agriculture, commercial, industrial, or tourism;
- property;
- historical and heritage;
- roadway and structure appraisals, and
- urban design studies.

2.3 Problem/Need Statement

Engineers should justify and rationalize projects using clear *problem/need statements* with supporting documentation. For projects that are expected to generate considerable public interest or controversy, engineers may consider an initial public consultation process, so that the public may be involved in assessing the problems and formulating problem statements.

2.4 Identification of Alternatives

Engineers should identify and develop a range of alternative solutions to problems. All reasonable alternatives should be identified and described, including the "do nothing" alternative.

2.5 Environmental Assessment† Requirements

At the conclusion of this phase of a project, engineers should establish which process the project must follow to meet the requirements of applicable federal and/or provincial environmental assessment regulations. In arriving at recommendations, engineers should follow the processes outlined in the most current versions of the following documents:

- *Class Environmental Assessment for Municipal Road Projects*, MEA
- *Provincial Highways Class Environmental Assessment*, MTO
- *Environmental Assessment Review Process*, Federal

ASSESSMENT OF ALTERNATIVES AND IMPACT ANALYSIS

Engineers should identify and develop basic alternative solutions in conceptual form, to resolve identified problems/needs and to meet project objectives. This may entail additional data acquisition for impact analysis.

3.1 Data Acquisition

To complete this phase of a project properly, engineers should review site conditions and research relevant data, as well as recommend and/or arrange for further collection of information or testing. Engaging specialists may be necessary.

In addition to the type of data identified in Section 2.2, they may require field survey work, as appropriate, and unit construction costs.

3.2 Alternative Solutions

Engineers should consider a range of solutions to identified problems, including functionally different alternatives to given solutions and alternative methods of implementing solutions. Alternatives may include:

- do nothing;
- physical modifications/improvements to existing facilities;
- new facilities;
- alternative modes of transportation, and
- operational improvements.

The "do nothing" alternative must also be considered as a benchmark for evaluation of other alternatives.

Alternatives should be developed in sufficient detail and illustrated in appropriate scales to facilitate subsequent evaluation and presentation at such events as public meetings. Depending on project needs and client requirements, perspectives, artist's renderings, electronic video imaging, or similar presentation materials may be necessary.

Cost estimates for alternatives under consideration may be required.

3.3 Impact Considerations

Engineers should identify the magnitude of net positive and negative effects of each alternative solution, taking into account each alternative's impact on the natural, social and economic environment. The level of detail required in this step may vary from project to project, depending on the relative significance of the effects under consideration.

Engineers should also identify appropriate measures to mitigate the negative environmental impact for each of the alternatives under consideration.

3.4 Evaluation of Alternatives

Engineers should establish what factors are appropriate for analyzing the alternatives and the relative importance of these factors in the analysis. They should develop procedures to permit systematic evaluation of alternatives for their advantages, disadvantages, adverse impacts and possible mitigating measures. These procedures should assist in the decision-making process, to help determine which alternative best meets the project's objectives.

Engineers should provide the necessary background information to allow the public, key stakeholders, review agencies, advisory committees and clients to evaluate the alternatives.

The evaluation process must be sensitive and flexible enough to accommodate changing conditions and new information as it becomes available. It should be phased, progressively narrowing the number of alternatives for further study. The objective is to obtain an overall consensus towards a preferred alternative.

It is important that recommended solutions at this phase be presented not as decisions but rather as preliminary preferences.

3.5 Review Agencies/Public Consultation

Engineers should identify and contact all review agencies, to solicit their comments and input. Some projects may be subject to federal laws, regulations or environmental assessment requirements.

Engineers should also identify projects' key stakeholders. These may include utility agencies, abutting property owners or businesses, community associations and interest groups.

Depending on a project's nature, engineers may be required to establish and consult with formalized technical and/or public advisory committees throughout its various stages.

Engineers should develop comprehensive communications plans, when these are required, to seek public input through a project's various stages. These plans should be developed according to any applicable guidelines established through provincial and/or federal environmental assessment processes.

Activities relating to a public participation/consultation program may include:

- preparing information brochures, pamphlets and advertising;
- preparing appropriate exhibits and displays;
- focus group/individual discussions;
- public meetings/drop-in centres;
- community association meetings;
- workshops/seminars;
- disseminating information through media, advertising or mailings, and
- establishing telephone hotlines, to disseminate information and to receive public input.

3.6 Selection of Preferred Solution

Selecting preferred solutions should ideally be based on overall consensus of projects' stakeholders and participants. If this is impossible, engineers should recommend preferred solutions, based on solutions' technical merits, minimizing environmental impact, requirements of review agencies and input from project participants.

Engineers should develop preferred solutions in sufficient detail and illustrate them at appropriate scales. They should explain reasons for selection and highlight potential environmental impacts and mitigation measures required. They should prepare recommended implementation programs and cost estimates.

At this point, engineers should review and confirm the environmental assessment process to be followed through a project's subsequent stages.

3.7 Project Documentation

Engineers should prepare and distribute their notes of the various meetings with the project team and other participants and the correspondence with various stakeholders, review and approval agencies and the public.

They should document the entire study process in a report form suitable for reference during the project's subsequent stages.

For bridge projects, they may be required to submit an environmental study report at this stage. For new transportation corridors, an individual environmental assessment report may be required. They should prepare these reports according to applicable provincial and/or federal guidelines.

PRELIMINARY DESIGN

Engineering services described in this phase relate to alternative methods of implementing preferred solutions. The work should normally be based on concepts and recommendations developed from project needs assessments and impact analyses. Engineers should prepare preliminary plans and/or reports for each alternative method, outlining the design criteria, and detailing environmental and economic assessments and cost estimates. These reports should include engineers' recommendations.

4.1 Data Acquisition

Engineers should request and/or collect all existing pertinent information, including any reports prepared under previous phases and the data used in their preparation. Engineers should review the site conditions with the data and information available, and recommend or arrange for further testing or collection of any information required to execute this phase of work properly. Acquisition of additional specialist services in addition to those identified in Section 3.1 may be necessary.

4.2 Preliminary Design Alternatives

Engineers should identify, analyze and select alternative methods of implementing preferred solutions. Factors to be considered in this analysis may include:

- design options, based on environmental, geometric, pavement types, structure configuration, construction staging, soils, drainage, utilities, traffic, landscaping, costs and property for both initial and ultimate stages;
- preparation of design criteria;
- preliminary design drawings, illustrating plans, profiles and cross sections;
- preliminary drainage design, relocation of utilities and services, road detours, railway diversions and illumination;
- property requirements, and
- capital and life cycle costs.

4.3 Impact Considerations

Engineers should identify the magnitude of net positive and negative effects of each preliminary design alternative, considering the impact of each alternative on the natural, social and economic environments. The level of detail may vary, depending on project requirements and each effect's relative significance.

Engineers should also identify the appropriate measures to mitigate any negative environmental impact for each of the alternatives under consideration.

4.4 Evaluation

The evaluation undertaken under this phase is similar to that described under Section 3.4, except that it should be more detailed.

4.5 Review Agencies/Public Consultation

During preliminary design, engineers should continue the consultation process with review agencies, stakeholders and the public as described in Section 3.5. Participants should also include all those who previously expressed interest and all those whom the project directly affects.

Services may include presentations at advisory, technical and public meetings.

4.6 Recommended Preliminary Design

Based on the foregoing work, engineers should select or confirm recommended preliminary designs. These should be developed in sufficient detail to facilitate review by review agencies, stakeholders and the public.

At this point, engineers should also review and confirm the environmental assessment process to be followed through a project's subsequent stages.

4.7 Documentation

Engineers should prepare for distribution notes of various meetings with project teams and other participants and correspondence with various review agencies, stakeholders and the public. At the conclusion of this phase, engineers should prepare preliminary design reports and/or an environmental study reports. Preliminary design reports may include:

- existing and future conditions, e.g. physiography, utilities, property limits, land use and highway access;
- traffic projections;
- design criteria;
- description and evaluation of all alternatives considered and rationale for selection of recommended preliminary designs;
- detailed descriptions of recommended preliminary designs;
- environmental impacts and mitigation;
- property requirements;
- project staging and scheduling;
- estimated project costs with breakdown into major items;
- cost sharing arrangements with other parties;
- commitments to be undertaken during design, and
- documentation of the consultation process.

Environmental study reports or environmental assessment reports should be prepared and filed according to applicable provincial and/or federal guidelines.

4.8 Approvals

If an environmental study report has been filed, it is necessary to wait a specified period to receive comments from the public. After this, the Ministry of Environment and Energy may either approve the project, require additional work be done to address concerns, or grant a "bump-up", which might necessitate a full environmental hearing. Whatever the outcome, engineers should prepare and submit the necessary applications for approval by appropriate regulatory agencies.

For projects under federal jurisdiction, engineers should also ensure that the requirements under the federal Environmental Assessment Review Process are met.

DETAILED DESIGN, CONTRACT DRAWINGS AND SPECIFICATIONS

Engineering services described in this phase relate to detailed design, drawings, specifications and contract package preparation for tendering of roads, bridges and associated facilities.

Road and associated facility design services may include, but are not limited to, such items as:

- site preparation;
- grading;
- granular base;
- pavement;

- sewers and drainage works;
- stormwater and water quality management facilities;
- curbs and gutters;
- sidewalks;
- guiderails;
- fencing;
- landscaping;
- detours;
- traffic staging;
- protection systems;
- illumination;
- traffic control devices, and
- traffic management and parking facilities.

In addition, structural design services may include, but are not limited to, such items as bridges, tunnels, culverts and drainage structures, retaining walls, sign and lighting supports, noise barriers, gabion structures, and associated temporary works and appurtenances.

An approved preliminary design report may be available at the start of the detailed design process. if not, clients should supply design criteria or request engineers to recommend appropriate criteria for approval.

Engineers may prepare work plans for the services to be provided and review them with clients. They should also arrange appropriate meetings with clients throughout projects to review progress.

Engineers should review with clients the use of computer automation in design.

5.1 Data Acquisition

Engineers may be provided with, or may be requested to provide or obtain as part of their services:

- copies of all previous planning, engineering or environmental reports, including an environmental study report where applicable;
- base plans at an appropriate scale, cross-sections, horizontal and vertical alignments and relevant survey data;
- property plans describing ownership and jurisdiction;
- utility location plans;
- geotechnical and geoenvironmental information;
- drainage plans;
- traffic data, and
- design criteria.

5.2 Detailed Design

Detailed design may include such elements as:

- site plans;
- geometric design;
- horizontal and vertical alignments;
- pavement design;
- typical cross-sections;

- design cross-sections;
- earth balance design;
- grading;
- drainage–quality and quantity, and storm sewer design;
- utilities;
- pavement elevations;
- illumination;
- traffic control devices;
- hydrotechnical design;
- foundation design;
- substructure design;
- superstructure design;
- barriers, railings, expansion joints, bearings, protection systems;
- traffic staging and detours, and
- property requirements.

Road and bridge designs must be undertaken according to the most recent municipal, provincial, federal, or other applicable standards.

The Engineer will plot design cross-sections that may show original ground line and new construction. These will be used for quantity calculations and grading design. Property requirements must be identified.

Utility conflicts and relocations must be identified and coordinated/negotiated with the appropriate utility agencies.

The engineering design must mitigate identified environmental effect.

5.3 Contract Drawings

Engineers will prepare contract drawings that meet clients' requirements. Engineers' seals and signatures should be on all drawings.

Drawings should clearly differentiate between original conditions and new construction, with all prominent features clearly labelled and design features identified by appropriate legends. Engineers may be required to prepare detailed plans to show non-standard details.

Drawings should include horizontal and vertical control data, if not provided in some other format.

Engineers should also ensure that, where necessary, appropriate property requirements (permanent or temporary) are identified and shown.

5.4 Contract Specifications

Engineers will prepare contract specifications to provide instructions to contractors. Specifications can be used to address construction practices, materials and methods of measurement and payment.

In preparing contract specifications, engineers should use clients' standard specifications wherever possible. They should produce non-standard specifications when necessary, and include special provisions to describe work not adequately addressed by standard or supplemental specifications.

5.5 Approvals

Engineers should prepare and submit applications for final approvals to appropriate regulatory agencies, and ensure that all relevant approvals have been received before award of the contract. They must obtain from private owners written permission to enter and/or construct.

Projects cannot proceed to construction before fulfilment of requisite environmental assessment requirements and approvals.

Engineers may be required to attend public information meetings and/or appear before municipal councils to explain and promote the rationale behind projects.

5.6 Quantities and Cost Estimates

Engineers should update quantity and cost estimates throughout the detailed design stage, and identify significant cost escalation items to clients as they arise.

They should prepare final quantity and cost estimates upon completion of detailed design and before tender call.

5.7 Tender Package

Engineers should prepare tender packages comprising contract drawings and tender documents.

Tender documents should include:

- the tender form;
- a list or copies of specifications;,
- special provisions;
- a list or copies of standard drawings;
- instructions for tenderers;
- a standard form of contract agreement;
- agreement to bond, and
- general conditions of contract.

5.8 Tender Call and Recommendations

Engineers should assist clients during the tendering process. This may include responding to inquiries on the tender package during the tendering period.

If requested by clients, engineers should administer the tender call. This may include:

- developing a schedule with a tender closing date that will permit adequate time for bidding and evaluation of responses before award;
- preparing and placing the appropriate tender advertisements for the contract;
- implementing a formal process for issuing tender packages, answering contractors' inquiries, issuing addenda and receiving bids, and
- analyzing the tenders and recommending contract award.

However, clients should have the right to reject any or all tenders.

5.9 Handover to Construction

Engineers should revise drawings for construction purposes. In addition to revised drawings and documents, engineers should ensure that contract administrators receive all pertinent precontract engineering data, such as:

- detailed calculations, including mass haul diagrams, if available;
- reinforcing steel schedules;
- design cross-section rolls;
- field notebooks;
- applicable computer files;
- cost sharing and recoverables;
- property agreements;

- permits and approvals;
- Board Orders, and
- commitments made during the environmental assessment process.

Engineers should arrange meetings with contract administrators, to provide an opportunity to discuss design details.

SERVICES DURING CONSTRUCTION

Engineers should monitor and review contractors' operations to confirm that contractors are discharging their obligations and responsibilities under the contract. Contract performance is not an engineer's responsibility, nor are engineers' review services rendered for contractors' benefit.

Engineers should notify contractors of any deficiencies in the construction of the work, instruct contractors to take appropriate corrective measures, and report results of corrective measures to clients.

They should understand that only work that has actually been seen during examination of representative samples can be said to have been appraised, and comments on the balance of the work are assumptions based upon extrapolation.

Engineers should provide services with the degree of care, skill and diligence normally associated with the performance of construction administration, by knowledgeable agents given the nature of the work and with due regard for all factors that may affect provision of services.

The extent of engineers' duties during construction should be clearly defined in their agreements with clients.

6.1 Contract Administration

Engineers should provide the following contract administration services:

- review drawings and documents pertaining to the contract, to identify errors and omissions;
- prepare agenda and minutes for contract-related meetings, such as the design package handover meeting, preconstruction meetings, and site meetings;
- review contractors' construction schedules;
- prepare progress and final quantity reports and payment certificates;
- prepare and submit to clients construction progress reports;
- consider and recommend acceptance or rejection of alternative construction methods or materials proposed by contractors;
- respond to specific external agency or public requests made during construction;
- issue all instructions to contractors, including instructions from clients;
- impartially interpret contract documents for clients and contractors, consistent with these documents' intent;
- investigate contractors' statements of changes in the character of the work, and provide to clients the results of such investigations and recommendations;
- issue appropriate instructions to contractors in response to statements of change in the character of the work;
- receive all notices of intent to claim, claims, disputes and other matters relating to contractors' performance and the quality of work or the interpretation of contract documents, and report them to clients;

- provide reports and recommendations to assist client's in dealing with claims, disputes and other matters relating to contractors' performance and the quality of work or the interpretation of contract documents;
- communicate client's decisions to contractors:
- review such submissions as shop drawings, mix designs and product data from contractors, and
- prepare change orders for contractors' signature, and instruct contractors to carry out changes.

6.2 Resident Inspection During Construction

Engineers should carry out the following for resident inspection related to the contract:

- coordinate, organize and control the activities of all staff employed in administering the contract, and coordinate their work activities with those of contractors;
- undertake all necessary record keeping in connection with: layout for construction purposes, if required; surveying for payment purposes; daily diaries on contract progress; equipment and personnel used by contractors daily, and measuring as necessary for payment record purposes, including acceptance of grades;
- carry out all on-site inspection, surveying, measuring, monitoring and review of construction and performance to ensure that work is constructed within the contract 's intent;
- reject unacceptable construction practices and deficient materials and work;
- provide reference surveys to contractors and, where necessary, check contractors' surveys;
- arrange for or carry out all necessary field testing and inspection of installed materials and equipment;
- investigate, report and advise on unexpected circumstances that may arise during construction, and
- arrange for specialist services as warranted.

6.3 Environmental Monitoring

For environmental monitoring, engineers should:

- ensure compliance with commitments made during the environmental assessment process and requirements contained in permits and approvals;
- inspect to ensure that mitigation measures are present, working and maintained to provide the expected level of control and/or protection;
- ensure that additional measures are provided to address unexpected environmental problems that develop during construction, and
- arrange for or carry out specialist environmental inspection services for projects having significant environmental sensitivities.

6.4 As-Built Documentation

Engineers may be required to provide such as-built documentation as:

- as-built drawings in reproducible format;
- testing and monitoring reports;
- change orders;
- inspectors' diaries and measurement records;
- photographic records, and
- preparation of project construction reports.

6.5 Acceptance

Engineers should provide such acceptance services as:

- joint inspections with representatives of contractors and/or clients, to establish the date of substantial performance and/or the date of the contract's completion;
- carry out or arrange for an inspection of the site, to determine whether there are any outstanding environmental issues;
- advise clients of any outstanding claims;
- prepare certificates of substantial performance and/or completion certificates;
- conduct inspections at completion and/or after the guaranteed maintenance period, as applicable.

RELATED SERVICES

The services in this category vary in scope, depending upon clients' needs. The following specialist services may be performed by project engineers or by other engineers under separate agreements with clients:

- geotechnical/geoenvironmental investigations;
- natural resources inventories and surveys, including fauna and flora characterization for ecologically sensitive developments;
- heritage and archaeological studies;
- property acquisitions and easement negotiations;
- stormwater management studies, and
- quality assurance and quality control (QA/QQ) tests.

Engineers are responsible for preparing terms of reference for and coordination of geotechnical/geoenvironmental investigations and QA/QC tests. Any other services provided by engineers in conjunction with the provision of specialist services should be considered as additional services, unless stated otherwise in engineers' agreements with clients.

7.1 "Bump-up" in the Class EA Process

The scope of the project will indicate the number of public meetings engineers are required to attend under the Class Environmental Assessment process. Any additional meetings and/or work resulting from a "bump-up" will be considered as additional engineering services.

Prepared by:

Ken Yu, P.Eng. (Chair)

Mike Chung, P.Eng.

Roger Hanmer, P.Eng.

Thomas Kazmierowski, P.Eng.

Virendra K. Sahni, P.Eng.

Roy Skelton, P.Eng.

William Wilcox, P.Eng.

Professional Engineers
Ontario

25 Sheppard Avenue West
Suite 1000
Toronto, Ontario
M2N 6S9

Tel: 416 224-1100 or 1-800-339-3716
Fax: 416 224-8168 or 1-800-268-0496

Enforcement Hotline: 416 224-9528 Ext.

Website: www.peo.on.ca